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(54) **A method of stabilising pile yarns of tufted woven or knitted pile products**

(57) A method of improving the tuft definition and appearance retention of pile fabrics includes (a) dispersing a bonding agent in fibrous or filament form between the discontinuous fibres or continuous filaments of a twisted pile yarn during a manufacturing process, (b) at a selected stage in the manufacturing process rendering adhesive all or part of the bonding agent so that after it bonds, the yarn structure is stabilised by inter-fibre bonding within the yarn tufts or loops of the pile fabric. At least some of the pile yarn in a fabric, carpet or rug is structured such that some or all of the fibres are bonded together intermittently and randomly substantially throughout the length of the pile tuft or loop.

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A METHOD OF STABILISING PILE YARNS OF TUFTED, WOVEN OR KNITTED PILE PRODUCTS

The present invention relates to a method of stabilising the pile yarns of tufted, woven or knitted yarn pile fabrics, especially carpets, rugs, upholstery fabrics and other textile products, by bonding together at least some of the fibres within the pile to improve wear and appearance characteristics.

Many textile fabrics consist of (a) tufts or loops, collectively known as pile, and (b) a backing or base structure from which the pile protrudes and which maintains the structural integrity of the whole fabric. The backing may be created at the same time as the pile is assembled together with the backing (as in carpet weaving of the type producing Axminster and Wilton carpets), or may have been manufactured prior to the process which creates the pile structure (as in the manufacture of tufted carpets). The pile may be in the form of (a) cut-pile, in which only one end of each pile tuft of yarn is attached to the backing, or (b) loop-pile, in which both ends of each pile loop are attached to the backing, or (c) both cut-pile and loop-pile.

Bonding of fibres together to form substantially twist-free yarns, which may or may have not have been false-twisted (that is, temporarily twisted) during bond formation, is known in the industry and is disclosed, for example, in British patent specification 452964. As known in the industry, the application of bonding methods to yarn manufacture, including those methods which employ thermally fusible fibres as the bonding agent, may be used either (a)

to provide a substitute for twist as a means of p rmitting the manufacture of a continuous structure (that is, yarn) from discontinuous fibres, as disclosed in British patent 1346899, or (b) to provide a method of producing high bulk in substantially twist-free yarns, as disclosed in British patent specification 1393712.

As is known to the industry, the application of bonding techniques to twisted yarn structures may be used (a) to provide cohesion in yarns and threads bonded with hot-melt powder adhesives, as in British patent specification 1270174, or (b) to provide adhesion at the surface of yarns used as structural members of the backing of carpets, which may increase the effectiveness of binding the pile yarns into the carpet but does not otherwise effect the pile yarns, as disclosed in British patent specification 1352311.

It is usually an objective of the manufacturing process to provide a fabric, carpet or rug having good appearance retention, i.e. one which will retain its original appearance to the maximum degree, despite the effects of wear, cleaning treatments or the normal hazards of use. In the case of cut-pile carpets it is also frequently an objective of the manufacturing process to provide a pile in which the individual tufts are visually discernible to a desired degree. The visual property by which tufts are individually discernible is usually known by the term tuft definition and is an important feature of the appearance of a pile fabric, especially a carpet. Inadequate tuft definition when new may

be a detrimental feature.

It is desired to ameliorate the above identified disadvantages and to effect an improvement in pile fabric manufacturing methods, appearance and performance, by means of applying a bonding method, employing thermally fusible fibres, to twisted yarns, such as to stabilise the pile of carpets, rugs, upholstery or other pile fabrics, whether they are tufted, woven or knitted. Reduction or loss of tuft definition is frequently a factor contributing to change of pile appearance during or as the result of use of a pile product such as a carpet.

Conventionally, the amount of twist in the pile yarn and the degree to which the yarn has been set (i.e. stabilised in its twisted configuration by a process or processes which expose the yarn to high temperature, water, steam or chemical setting agents, in order to relax or minimise the strain energy in the fibre due to the fibre deformation caused by twisting) are major factors determining both the initial tuft definition when manufactured and the retention of tuft definition in use.

It is also desired to provide a method of improving initial tuft definition and the retention of tuft definition in pile products, especially carpets, rugs and upholstery fabrics without resorting to increased levels of pile yarn twist.

It is further desired to provide a method of enabling acceptable tuft definition to be

achieved at less than usual yarn twist levels, thereby enabling manufacturing cost to be reduced.

It is yet further desired to reduce the fibre loss or fibre shedding which occurs as a result of wear and cleaning treatments, both of which may cause discontinuous fibres (whether natural fibres, man-made fibres or synthetic fibres) loosely bound into the pile yarn to become detached from the carpet structure.

It is also desired to reduce the amount of fibre protruding from but attached to the pile surface of the pile structure which causes a hairy or fuzzy appearance, which is frequently considered undesirable, especially in loop-pile carpets or rugs.

According to an aspect of the present invention there is provided a method of improving the tuft definition and appearance retention of pile fabrics which includes (a) dispersing a bonding agent in fibrous or filament form between the discontinuous fibres or continuous filaments of a twisted pile yarn during a manufacturing process, (b) at a selected stage in the manufacturing process rendering adhesive all or part of the bonding agent so that after it bonds, the yarn structure is stabilised by inter-fibre bonding substantially within the yarn tufts or loops of the pile fabric.

According to the present invention at least some of the pile yarn in a fabric, carpet or rug is structured such that some or all of the fibres within the pile yarn are bonded

together intermittently and randomly substantially throughout the length of the pile tuft or loop formed from the pile yarn.

Preferably the bonding agent is a heat sensitive fibre or filament so that by temporarily raising the temperature of the manufacturing process sufficiently to melt wholly or partially at least part of the bonding agent, such that after cooling the pile and yarn structure is stabilised by inter-fibre bonding within the structure.

The method is applicable to any twisted yarn structure containing continuous or discontinuous fibres and to twisted yarn structures containing continuous filaments.

The bonding agent can consist of bonding fibres (known to the industry) of which at least part of the surface can be melted. The wholly or partially fusible fibres bond to each other or to contiguous non-adhesive fibres which are in the yarn. The term non-adhesive fibres as used herein means fibres which remain non-adhesive at and below the temperature required for bonding. The bonding fibres can be bicomponent fibres in which one component melts and becomes adhesive at a lower temperature than does the other component. The component having the lower melt temperature comprises part of or all of the surface of the bonding fibre. Alternatively, the bonding fibres can be mono-component types in which the melting temperature is similar throughout the fibre. The non-adhesive fibre present can be a natural, man-made or synthetic fibre which does not melt at the temperature required for bonding. If the non-adhesive fibre is in

continuous filament form then the bonding fibre can for manufacturing convenience be in continuous filament form.

In use with a bonding agent consisting of bonding fibres, the dispersion of the bonding fibres among the non-adhesive fibres can be achieved by conventional textile blending techniques. The blend of bonding and non-adhesive fibres may be processed to yarn form by any of the following fibre-to-yarn manufacturing techniques, woollen (condenser) spinning, semi-worsted spinning, worsted spinning, wrap spinning, friction spinning, open-end spinning, cotton spinning or modified cotton spinning. When the bonding and non-adhesive components are in continuous filament form, the dispersion of one among the other can be achieved by any known fluid-jet intermingling technique.

The application of heat to effect bonding may be most beneficially carried out before fabric manufacture during production of a cut-pile fabric and before or after manufacture of a loop-pile fabric. The heating medium can most efficiently be a hot fluid such as air or steam.

Further aspects of the invention which should be considered in all its novel applications will become apparent from the following examples.

EXAMPLE 1

In this example of the invention, a 2-fold (i.e. comprised of two singles yarns plied together) woollen spun pile yarn containing 85% wool fibres and 15% of a bicomponent

polyester bonding fibre was bonded by a heat treatment before tufting into cut-pile carpet. The bonding fibre was 4 denier 51 mm Melty Type 4080 manufactured by Unitika Limited, 4-68 Kitakyutaro-Machi, Higashi-ku, Osaka, Japan. Blending of the wool and bonding fibre was carried out by conventional stack or sandwich blending followed by two passages of the fibres through a wool opening machine and by conventional woollen (condenser) carding. Following conventional woollen spinning and two-folding, the R500/2 tex yarn produced was bonded by heat-treatment in hank-form in a steam autoclave at 140 degrees C for 30 seconds. The singles yarn twist was 170 turns per metre (tpm) and two levels of folding twist were used to produce (a) a sample containing 160 tpm folding twist and (b) a sample containing 120 tpm folding twist.

Testing and subjective examination of the bonded yarn and a carpet manufactured from the yarn gave the following results considered by the applicants to be illustrative of the benefits of the invention.

1. When snippets (12mm lengths) of the bonded yarn were tested on a WRONZ Set Tester at 50 degrees C for 500 cycles using a 12mm orifice size, no snippet breakdown occurred, indicating a very high degree of stability.

2. When tufts of yarn were withdrawn from the backing (before application of latex to the backing) and subjected to 60 seconds in an air turbulence chamber, the bonded yarn tufts remained intact, whereas tufts similarly obtained and tested from a comparable 100%

wool non-bonded, conventionally autoclave-set (at 110 degrees C for 2 minutes, followed by a further 10 minutes at 110 degrees C, in steam) yarn, were, in the majority of tufts, largely disintegrated.

3. When samples of the carpet were examined visually, the tuft definition of carpets containing bonded pile yarn was more distinct than that of comparable carpet containing comparable autoclave-set 100% wool yarn: the improvement in tuft definition due to bonding was greater at the lower twist level.

4. When samples of the carpet were subjected to a simulated stain removal test, in which 100 ml water at 60 degrees C was poured on to the specimens and then sponged off, the carpets containing bonded pile yarn lost less tuft definition than those containing comparable autoclave-set 100% wool yarn: the improvement in appearance retention due to bonding was greater at the lower twist level.

5 When samples of the carpet were subjected to an instrumental simulated wear test (International Wool Secretariat Test Method 237: Tetrapod wear test) and subsequently tested and examined subjectively by a panel of experienced assessors, it was found that:

(a) the pile thickness loss was less for the bonded carpets than for comparable autoclave-set 100% wool carpets;

(b) the deterioration in textural appearance was

less for the bonded carpets than that of comparable autoclave-set 100% wool carpets;

(c) the change in colour of the bonded carpets was less than that of comparable autoclave-set 100% wool carpets; and

(d) the quantity of fibre loss (fibre detached from the pile of the carpet) was less for the bonded carpets than for the comparable autoclave-set 100% wool yarn.

EXAMPLE 2

Four singles woollen-spun yarns were spun to 500 tex with 100 turns per metre twist, containing 0, 5, 10 and 15% respectively of 4 denier 51 mm Melty Type 4080 bicomponent polyester bonding fibre. The non-polyester component of the yarns was a blend of New Zealand carpet wools. The all-wool yarn was autoclave-set in saturated steam 110 degrees C for 1 cycle of 2 minutes, followed by 1 cycle of 110 degrees C for 10 minutes. The yarns containing bonding fibre were autoclave-bonded in saturated steam for 30 seconds at 138 degrees C. Each of the yarns was then tufted to a 10 mm pile height, 1/8 inch gauge, cut-pile carpet construction, with 310 stitches per (linear) metre. After conventional latex backing, including lamination of a jute secondary backing to the carpet, testing and subjective assessment of the carpet gave the following results.

1. Testing of yarn wet stability in the WRONZ Set Tester (as in Example 1) showed that the proportion of yarn snippets which substantially disintegrated during the test was

0% bonding fibre	100%
5% bonding fibre	64%
10% bonding fibre	1%
15% bonding fibre	0%

which indicated that bonding improved the yarn wet stability.

2. When samples of the carpets were compared visually by 20 judges, each making independent assessments, the tuft definition was found to increase with increasing porportion of bonding fibre in the carpet (a) for new, unused carpet samples, (b) for worn and soiled carpet samples after a floor trial, (c) for carpet samples which had been steam-cleaned after a period of wear and soiling and (d) for carpet samples which had been rotary brush shampoo cleaned after a period of wear and soiling.

3. When samples of the carpets were subjected to a simulated stain removal test (as in Example 1), the retention of tuft definition increased as the proportion of bonding fibre in the blend increased. In the opinion of experienced judges the retention of tuft definition of the bond-pile carpets was considered commercially acceptable and that of the non-bonded (100% wool) carpet was considered commercially unacceptable.

EXAMPLE 3

Yarns made and stabilised as in Example 2 were tufted to a 10 mm pile height, 5/32 inch gauge, loop-pile carpet construction with 360 stitches per metre. After an instrumental simulated carpet wear test (Tetrapod test, as in Example 1), the measured fibre loss was found to be:

0% bonding fibre	1.87grams/square metre
5% bonding fibre	0.34grams/square metre
10% bonding fibre	no detectable loss
15% bonding fibre	no detectable loss,

indicating that pile bonding reduced fibre loss in the simulated wear conditions.

EXAMPLE 4

Two-fold yarns of R500/2 tex with 170 turns per metre singles twist and 140 turns per metre folding twist (in the opposite direction of twisting), but otherwise similar to the yarns described in Example 2, were tufted to loop-pile carpet as described in Example 3. After an instrumental simulated wear test the measured fibre loss was found to be:

0% bonding fibre	2.21 grams/square metre
5% bonding fibre	0.17 grams/square metre
10% bonding fibre	no detectable loss
15% bonding fibre	no detectable loss,

indicating that pile bonding decreased fibre loss in the simulated wear conditions.

EXAMPLE 5

Two fold yarns made and stabilised as in Example 4 were tufted into cut-pile carpet as described in Example 2. Testing of yarn wet stabiity, as in Example 1, showed that the proportion of yarn snippets which disintegrated during the test was:

0% bonding fibre	100%
5% bonding fibre	58%
10% bonding fibre	13%
15% bonding fibre	1%

which indicated that bonding increased the yarn wet stability.

When samples of the carpets were compared by 20 judges, each making independent assessments, the tuft definition was found to increase as the proportion of bonding fibre increased, for new, unworn carpets. The tuft definition was found to be greater at 10% and 15% bonding fibre content than at 5% bonding fibre content, which in turn was greater than that of the unbonded 100% wool yarn, (a) for carpet samples which had been worn and soiled in a floor trial, (b) for carpet samples which had been steam cleaned after wear and soiling in a floor trial, and (c) for carpet samples which had been rotary-brush shampoo cleaned after wear and soiling in a floor trial.

EXAMPLE 6

An objective measure of tuft definition, using an image

analysis technique, and indicated in terms of a parameter (defined in WRONZ Communication C105, 1987, as Local Intensity Variability Mean, or LIV mean) in which larger values indicate greater tuft definition, was used to characterise singles-yarn cut-pile carpets as described in Example 2 and 2-fold yarn cut-pile carpets as described in Example 5. The measured values for new, unworn carpet samples and for carpet samples subjected to a Tetrapod simulated wear test (as described in Example 1) are shown in the following two tables.

LIV mean for singles-yarn carpet

Bonding fibre %	New	Worn
0	14.3	13.6
5	18.2	15.2
10	17.1	16.3
15	18.1	16.5

LIV mean for 2-fold yarn carpet

Bonding fibre %	New	Worn
0	13.9	12.4
5	15.4	13.4
10	15.7	15.0
15	16.8	15.9

The bonded-pile carpets were found to have greater tuft definition than the comparable 100% wool yarns, both when new and after simulat d wear.

EXAMPLE 7

Singles woollen-spun yarn containing 90% carpet wool and 10% 4 denier 51 mm bicomponent polyster bonding fibre was spun to 250 tex with 170 turns per metre twist. Two-fold 500 tex yarn with 140 turns per metre twist (in the opposite direction of twisting) was made by testing two of the singles yarn together.

The two-fold yarn was heat-treated (to effect the bonding) on a package-to-package yarn continuous heat treating machine of a type known to the industry and commonly used for heat-setting nylon carpet yarns and carpet yarns containing other fibres. Samples of the yarn were so treated at 600 metres per minutes yarn speed, equivalent to 67 seonds dwell time in the chamber containing air and super-heated steam at temperatures ranging from 145 degrees C to 190 degrees C. All of the samples were found to have a high degree of twist stability and resistance to disintegration when subjected to the WRONZ Set Test described in Example 1.

EXAMPLE 8

Singles semi-worsted-spun yarn containing 90% carpet wool and 10% of 15 denier 76 mm bicomponent polyester was spun to 310 tex with 136 turns per metre twist. Two-fold 620 tex yarn was then made by twisting together two ends of the singles yarn with 100 turns/metre (in the opposite direction of twisting). After heat-treating in an autoclave at 140

degrees C for 30 seconds in saturated steam, the yarn was then tufted to 11mm pile height carpet in a 5/32 inch gauge cut-pile construction with 290 stitches per metre. The yarn and carpet were compared with similarly constructed 100% wool yarn and carpet.

The bond-stabilised yarn had a higher degree of twist stability and resistance to disintegration in the WRONZ Set test than the autoclave-set 100% wool yarn, as indicated by the following percentage of yarn snippets which disintegrated in the test conditions:

(a) the bond-stabilised 90% wool yarn had 25% of snippets disintegrated after 400 cycles,

(b) the autoclave-set 100% wool yarn had 100% of snippets disintegrated after 50 cycles.

An objective measure of tuft definition using an image analysis technique and described in Example 6 showed that the bond-stabilised carpet pile lost less tuft definition than the autoclave-set 100% wool yarn (a) after wear and soiling in a floor trial, (b) after steam-cleaning following the floor trial and (c) after rotary-brush shampoo cleaning following the floor trial.

When subjected to a test for loss of fibre (termed fibre shedding), which test consisted of continuous abrasion and vacuuming for 2 hours under a traversing vacuum slot pressing upon the carpet pile, the bond-stabilised pile carpet lost less fibre than the autoclave-set 100% wool pile carpet.

The bond-stabilised pile carpet was also found to have

better cover (that is, less space between the tufts), a more upright pile and displayed less thickness loss when worn than the autoclave-set 100% wool yarn.

EXAMPLE 9

Singles 255 tex woollen-spun yarn containing 9% bicomponent polyester bonding fibre and 91% carpet wool and having 190 turns per metre twist was twisted to form three two-fold yarns of 510 tex having respectively 150, 180 and 210 turns per metre folding twist. The yarns were autoclave-bonded at 131 degrees C for 20 seconds and were then tufted to 14 mm pile height carpet in 1/8 inch gauge cut-pile construction with 360 stitches per metre.

The unbacked carpets were beck-dyed (alternatively termed winch-dyed, a process known to the trade) with disperse and acid-levelling dyestuffs colouring both polyester and wool components of the carpets. The beck-dyeing process is known to the industry to require a high degree of pile yarn stability to resist the tendency of pile tufts to lose definition during the process and consequently to form a visually undesirable texture.

The resultant carpets which had bond-stabilised pile had excellent tuft definition, which was as good as or better than that of carpets of the same construction containing chemically set 100% wool yarns of the same construction.

Thus by this invention there is provided a method of stabilising the pile structure of a tufted, woven or knitted

yarn pile product.

Particular examples of the invention have been described herein and it is envisaged that improvements and modifications can take place without departing from the scope of the appended claims.

CLAIMS

1. A method of improving the tuft definition and appearance retention of yarn pile fabrics, including carpets, by means of which some or all of the fibres within the pile yarn are bonded together by a bonding agent.

2. A method of improving the tuft definition and appearance retention of pile fabrics which includes (a) dispersing a bonding agent in fibrous or filament form between the discontinuous fibres or continuous filaments of a twisted pile yarn during a manufacturing process, (b) at a selected stage in the manufacturing process rendering adhesive all or part of the bonding agent so that after it bonds the yarn structure is stabilised by inter-fibre bonding substantially within yarn tufts or loops of the pile fabric.

3. A method of stabilising the pile of cut-pile fabrics according to Claim 1 or Claim 2 in which the bonding agent consists of bonding fibres, at least part of the surface of which can be rendered adhesive by heating to cause melting, and in which the bonding agent comprises between 3% and 25% of the bond-stabilised pile yarn.

4. A method of stabilising the pile of cut-pile and loop-pile fabrics according to any one of the preceding Claims, in which the pile yarn contains non-adhesive fibres, which can be natural fibres, man-made or synthetic fibres or any mixture of natural, man-made or synthetic fibres, as well as bonding agent.

5. A method of stabilising the pile of cut-pile and

loop-pile fabrics according to claim 4, in which the pile yarn is a singles or plied yarn containing real twist constructed according to woollen-spun, semi-worsted-spun, wrap-spun, friction-spun, open-end spun, cotton-spun or modified cotton-spun processing techniques.

6. A pile fabric or carpet, constructed according to the method of any of the preceding claims.

7. A pile fabric or carpet, according to Claim 6 in which the pile yarn contains a non-adhesive component in the form of a continuous filament(s) together with a bonding agent in the form of a continuous filament(s) of which at least part of the surface can be rendered adhesive by heating to cause melting.

8. A pile fabric according to Claim 6 which contains some non-bonded yarns in order to provide textural contrast between the bonded and non-bonded yarns.

9. A pile fabric constructed according to Claim 6, in which the pile is cut-pile or loop-pile.

10. A method of producing pile fabric substantially as hereinbefore described according to any of examples 1 to 5 and 7 to 9 herein.

11. Pile fabric substantially as hereinbefore described and produced according to any one of the examples 1 to 5 and 7 to 9 herein.

Amendments to the claims
have be n filed as follows

CLAIMS

1. A method of improving the tuft definition and appearance retention of yarn pile fabrics, including carpets, by stabilising real twist in the pile yarn by bonding together some or all of the discontinuous fibres or continuous filaments within the yarn, which bonding is effected in a separate process subsequent to the process of insertion of real twist into the yarn.

2. A method of improving the tuft definition and appearance retention of yarn pile fabrics according to claim 1, which includes:

(a) dispersing or blending a bonding agent in fibre or filament form among non-adhesive fibres or filaments to be formed into the pile yarn,

(b) forming either a singles yarn containing real twist or optionally forming a plied yarn by twisting 2 or more singles yarns together,

(c) after the pile yarn has been formed and optionally plied and before a pile fabric is manufactured, rendering adhesive all or part of the bonding agent, so that after it bonds the twisted yarn structure is stabilised by inter-fibre bonding.

3. A method of stabilising the pile of cut-pile fabrics according to claim 1 or claim 2 in which the bonding agent consists of bonding fibres, at least part of the surface of which can be rendered adhesive by heating to cause melting, and in which the bonding agent comprises between 3% and 25% of the bond-stabilised pile yarn.

4. A method of stabilising the pile of cut-pile and loop-pile fabrics according to any one f the preceding claims, in which the pile yarn c ntains non-adhesive

fibres, which can be natural fibres, man-made or synthetic fibres or any mixture of natural, man-made or synthetic fibres, as well as bonding agent.

5. A method of stabilising the pile of cut-pile and loop-pile fabrics according to claim 4, in which the pile yarn is constructed according to woollen-spun, semi-worsted-spun, worsted-spun, wrap-spun, friction-spun, open-end spun, cotton-spun or modified cotton-spun processing techniques.

6. A pile fabric or carpet, constructed according to the method of any of the preceding claims.

7. A pile fabric or carpet, according to claim 6 in which the pile yarn contains a non-adhesive component in the form of a continuous filament(s) together with a bonding agent in the form of a continuous filament(s) of which at least part of the surface can be rendered adhesive by heating to cause melting.

8. A pile fabric according to claim 6 which contains some non-bonded yarns in order to provide textural contrast between the bonded and non-bonded yarns.

9. A pile fabric constructed according to claim 6, in which the pile is cut-pile or loop-pile.

10. A method of producing pile fabric substantially as hereinbefore described according to any of examples 1 to 5 and 7 to 9 herein.

11. Pile fabric substantially as hereinbefore described and produced according to any one of the examples 1 to 5 and 7 to 9 herein.

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